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Mathematics and Computer Science

Saint Mary's College of California

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MATHEMATICS AND COMPUTER SCIENCE

Mathematics is a liberal art fundamental to a true education. It trains students in analytical thinking, and courses are offered with application to the natural and social sciences. Graduates of the department are active in an extraordinarily wide range of careers. The department offers a science degree in mathematics with a pure applied and computer science track.

A minor in mathematics is available.

FACULTY

Jim Sauerberg, Ph.D., *Professor, Chair*

Kristen Beck, Ph.D., *Assistant Professor*

Andrew Conner, Ph.D., *Assistant Professor*

Charles R. Hamaker, Ph.D., *Professor*

Chris Jones, Ph.D., *Professor*

Brother Brendan Kneale, FSC, M.A., M.S., *Associate Professor Emeritus*

Lidia R. Luquet, Ph.D., *Professor Emerita*

Michael Nathanson, Ph.D., *Associate Professor*

Brother Raphael Patton, FSC, Ph.D., *Professor Emeritus*

Kathryn F. Porter, Ph.D., *Professor*

Jane R. Sangwine-Yager, Ph.D., *Professor Emerita*

Ellen Veomett, Ph.D., *Associate Professor*

LEARNING OUTCOMES

When they have completed a mathematics major, students will be able to:

- **DEMONSTRATE** a mastery of the core SMC undergraduate mathematics curriculum.
- **COMMUNICATE** mathematical ideas and concepts correctly and clearly in both oral and written forms using mathematical reasoning and terminology and symbolic representation.
- **UNDERTAKE** scholarly investigations using appropriate mathematical resources.
- **INTEGRATE** the use of technological tools into their investigations.
- **DEMONSTRATE** knowledge of connections within mathematics and applications to other fields.

MAJOR REQUIREMENTS

A student wishing to major in mathematics should have a strong interest in the field and normally a background of four years of high school mathematics (two years of algebra, one year of geometry and one year of precalculus or equivalent).

The Department of Mathematics and Computer Science offers three tracks within the mathematics major. There is a Pure, an Applied, and a Computer Science track and all tracks are Bachelor of Science degrees.

LOWER DIVISION

The following lower-division classes are required for all tracks in the mathematics major.

Math 27, 38, 39, Computer Science 21

Plus either **Physics 1-4** OR **Chemistry 8-11**

PURE TRACK

The pure track is designed for students considering graduate study in mathematics or secondary mathematics teaching.

Required upper division courses

Math 103, 111, 120, 150 and 193

Plus two additional courses from

Math 115, 131 and 183

Plus three upper division mathematics courses.

APPLIED TRACK

The applied track is designed for students planning on entering industry directly from college.

Required upper division courses

Math 103, 120, and 193

Plus one additional course from

Math 111 or 150

Plus three additional courses from

Math 113, 114, 134 and CS 102

Plus two upper division electives at most one of which is a CS course.

COMPUTER SCIENCE TRACK

The Computer Science track is designed for students interested in an emphasis in Computer Science.

Required upper division courses

Math 103, 120, 140 and 193 and CS 102

Plus one additional course from

Math 111 or 150

Plus three upper-division electives at least two of which are CS courses.

SUGGESTED FOUR-YEAR PROGRAM

A suggested four-year program of study for a major in mathematics is available from any department member. First-year students should take **Math 27** and **38** and **CS 21**. Failure to take these courses in the first year may make it impossible to complete the major in four years. Students wishing to concentrate in computer science should take both **CS 21** and **102** in the first or second year. It is also recommended for students to enroll in **Physics 1, 2, 3, 4** or **Chemistry 8, 9, 10, 11** in the first year.

MINOR REQUIREMENTS

The minor in mathematics requires **Math 27, 28** or **38, Math 103** (**Math 39** and/or **Math 120** are recommended), and two more upper-division courses in mathematics.

SECONDARY TEACHING

All students in California planning to enroll in a teaching credential program in mathematics after earning their undergraduate degree are required to demonstrate subject matter competency in mathematics prior to admission to a credential program. Students at Saint Mary's College exhibit this competency by taking and passing the CSET (California Subject Exam for Teachers) in mathematics. Students interested in becoming a secondary mathematics teacher are advised to complete the following upper-division courses to prepare for the CSET while fulfilling the mathematics major. **Math 103, 111, 113, 115, 120, 131, 150, 193.**

The California Commission on Teacher Credentialing (CCTC) also requires students to obtain "pre-professional field experience" before entering a credential program. This requirement is satisfied by the course **EDUC 122: Field Experience**, offered in the January Term at SMC. Students are required to contact the School of Education in September of their sophomore or junior year to meet with the faculty member teaching **EDUC 122**. Students should also speak with a representative of the School of Education to learn of any other requirements of the state of California for prospective secondary teachers.

C O U R S E S

PREREQUISITE GRADE

*Any course listed in this department with a prerequisite requires a grade of C– or better in the prerequisite course, including the high school courses algebra I, geometry and algebra II which are prerequisites of all mathematics and computer science courses except **Math 2** and **12**.*

LOWER DIVISION

2 Mathematics Readiness

This course covers basic algebra and geometry concepts including number systems, polynomials, solving equations and inequalities, graphs, functions, lines, systems of equations, sets and operations, ratios, proportions, measurement and percents. Emphasis will be placed on problem solving, critical thinking and mathematical reasoning. *Prerequisites: One year each of high school algebra I and geometry. Students who have also completed algebra II with a C– or better should take the Placement Exam before taking this course. Offered every semester.*

3 Finite Mathematics

Topics and applications in this course are selected from linear equations and matrices, linear programming, probability, finance, Markov chains, game theory and graphs. The emphasis is on applications to business and management sciences. *Prerequisites: One year each of high school algebra I, II and geometry or equivalent and a passing score on the placement exam. Seniors are not permitted to enroll in this course. Offered every semester. This course satisfies the Mathematical Understanding requirement of the Core Curriculum.*

4 Introduction to Probability and Statistics

This course covers the study of combinations and permutations, descriptive and inferential statistics, probability and probability distributions, hypothesis testing, regression and correlation, along with applications in a variety of practical settings. This course may not be taken for credit in addition to **Business Administration 40** or **Psychology 3**. *Prerequisites: One year each of high school algebra I, II and geometry or equivalent, and a passing score on the placement exam. Offered every semester. This course satisfies the Mathematical Understanding requirement of the Core Curriculum.*

5 Mathematics Concepts for the Elementary School Teacher I

This course is the first in a two-course sequence designed for the mathematical preparation of the future elementary school teacher. The content addressed in this course covers three of the five California Mathematics Standards; these standards are (i) Number and Quantity, (ii) Algebra and Functions, and (iii) Modeling and Problem Solving. Emphasis will be placed on connecting the mathematical content with the Standards of Mathematical Practice from the California Common Core State Standards of Mathematics. This course is only for education track and Teacher for Tomorrow program students in the Justice, Community, and Leadership program. *Prerequisites:* One year each of high school algebra I, II and geometry or equivalent, and placement into the course. Does NOT satisfy the Mathematical Understanding requirement of the Core Curriculum mathematics requirement. Offered every fall.

6 Mathematics Concepts for the Elementary School Teacher II

This course is the second course in the two-course sequence designed for the mathematical preparation of the future elementary school teacher. The content addressed in this course covers two of the five California Mathematics Standards; these standards are (i) Geometry and (ii) Probability and Statistics. Emphasis will be placed on connecting the content with the Standards of Mathematical Practice from the California Common Core State Standards of Mathematics and mathematical reasoning. This course is only for education track and Teacher for Tomorrow program students in the Justice, Community, and Leadership program. *Prerequisites:* **Math 5**. This course satisfies the Mathematical Understanding requirement of the Core Curriculum. Offered every spring.

10 The Art and Practice of Mathematics

A reflective examination of basic mathematical ideas and patterns. Through participation in the discovery and development of mathematical ideas the student will view the subject as a vehicle for human creativity. The course traces the historical and contemporary role of appropriate mathematical topics. *Prerequisites:* One year each of high school algebra I, II and geometry; **English 5** and **Collegiate Seminar 1**. Offered every semester. This course satisfies the Mathematical Understanding requirement of the Core Curriculum.

12 Mathematics Readiness for Calculus

This course includes the basic study of number systems, linear equations and inequalities, quadratic equations and inequalities, polynomials, rational expressions, radicals, exponentials, functions, inverse functions, logarithmic and exponential functions, angles, triangles, surface area, volume and applications. Emphasis will be placed on problem solving, critical thinking and mathematical reasoning. *Prerequisites:* One year each of high school algebra I and geometry. Students who have also completed algebra II with a C– or better should take the placement exam before taking this course. Offered in the fall.

13-14 Calculus with Elementary Functions I, II

A survey of polynomial, trigonometric, logarithmic and exponential functions combined with differential calculus of functions of one variable and mathematical reasoning. This calculus sequence is intended for students who need to strengthen their precalculus skills. The sequence **Math 13-14** is equivalent to **Math 27**. *Prerequisites:* for **Math 13**: one year each of high school algebra I, II and geometry or equivalent and a passing score on the placement exam. **Math 13** or equivalent is prerequisite to **Math 14**. Offered every semester. This course satisfies the Mathematical Understanding requirement of the Core Curriculum.

27 Calculus I

Limits, continuity, mathematical induction, mathematical reasoning, the derivative, applications of the derivative, antiderivatives and the integral. *Prerequisites:* one year each of high school algebra I, II and geometry, Precalculus, or equivalent, and a passing score on the placement exam. Offered every semester. This course satisfies the Mathematical Understanding requirement of the Core Curriculum.

28 Calculus II with Applications

This course is designed for students majoring in the life sciences, health sciences, business administration, psychology and accounting. Topics include techniques and applications of integration, first order differential equations, functions of several variables, double integrals and applications. *Prerequisite:* **Math 27** or equivalent. Offered every semester.

38 Calculus II

This course is designed for mathematics, physics, computer science, engineering and chemistry majors. Topics include techniques and applications of integration, infinite sequences and series, power series, polar coordinates and inverse trigonometric functions. *Prerequisite:* **Math 27** or equivalent. Offered every spring.

39 Calculus III

A rigorous treatment of limits for functions of one and several variables, differentiation and integration of functions of several variables, coordinate systems, vectors, line and surface integrals, Green's, Stokes' and the divergence theorem. *Prerequisites:* **Math 38** or equivalent. Offered every fall.

Curriculum Mathematics and Computer Science

UPPER DIVISION

Math 120, 134 and 193 are offered annually. Most of the other upper-division courses are offered on a biannual rotation. Contact the department chair for the schedule.

103 Intro. to Upper Division Mathematics

This course is an introduction to mathematical logic and proofs and includes an introduction to Abstract Algebra. Students will learn to write proofs using standard proof-writing organization and terminology. Topics from algebra will include the division algorithm, modular arithmetic, rings and groups. *Prerequisites: English 5 and Math 38, or equivalent. Completion of Math 103 and Math 193 satisfies the Writing in the Disciplines requirement of the Core Curriculum.*

111 Abstract Algebra I

Topics covered include Modules, vector spaces, fields and Galois theory. *Prerequisites: Math 103 and 120 or permission of instructor.*

113 Probability and Statistics

Discrete and continuous random variables, expectation and variance, independence, distributions and the Central Limit Theorem. Survey of statistical methods: estimation, sampling, hypothesis testing, linear regression and confidence intervals. *Prerequisites: Math 28 or 38, or equivalent.*

114 Mathematical Modeling

An introduction to the formulation, analysis and interpretation of results of mathematical models in the study of real-life problems chosen from the various areas of natural sciences, social sciences, economics and business. *Prerequisites: Math 28 or 38, or equivalent, and CS 21.*

115 Number Theory

Results studied include the Fundamental Theorem of Arithmetic, the Euclidean algorithm, Fermat's Little Theorem and Euler's generalization, Diophantine equations and the Law of Quadratic Reciprocity. *Prerequisites: Math 103 or permission of instructor.*

120 Linear Algebra with Applications

Matrices, simultaneous linear equations, linear transformations, vector spaces, bases, determinants, eigenvectors, Gram-Schmidt orthonormalization, techniques of mathematical proof and applications of linear algebra. *Prerequisites: Math 28 or 38 or equivalent.*

131 Topology

This course covers the fundamentals of point-set topology including topological spaces, metric spaces, continuous maps, separation axioms, connectedness, and compactness. *Prerequisite: Math 103 or permission of instructor.*

134 Differential Equations

Ordinary differential equations, existence and uniqueness theorems, some numerical methods, Laplace transforms, series solutions, linear systems with constant coefficients, partial differential equations, separation of variables, Fourier series. *Prerequisites: Math 39, or Math 38 and Math 120, or equivalent.*

140 Combinatorics and Discrete Mathematics

This course focuses on discrete structures and their relations. Topics may include counting techniques, relations, graph theory and logic. *Prerequisites: Any one of these pairs: Math 28 or 38 or equivalent.*

150 Advanced Calculus

A rigorous review of the theory of single variable calculus, topology of n -space, integration and differentiation, improper integrals, differential forms, the theorems of Stokes and Gauss. *Prerequisites: Math 39 and Math 103, or permission of instructor.*

185 Complex Variables

Differentiation and integration of analytic functions of a complex variable, power series, residues, conformal mappings. *Prerequisites: Math 39 and Math 103, or permission of instructor.*

190 Special Topics in Mathematics

An upper division mathematics course not listed above, such as differential geometry, numerical analysis, topology or real analysis. May be repeated for credit as topics vary. *Prerequisites: vary with topics.*

193 Senior Seminar

An in-depth critical examination of a topic or topics in contemporary mathematics. The course consists of directed reading, presentations, research and the writing of a final essay under the supervision of the instructor. At the conclusion of the semester students are expected to present their work at a departmental colloquium of faculty and students. The essay is evaluated by a committee consisting of the faculty supervisor and two other faculty chosen in consultation with the student. *Prerequisites: Math 103 or consent of instructor. Senior or second-semester junior standing required. Completion of Math 103 and Math 193 satisfies the Writing in the Disciplines requirement of the Core Curriculum.*

197 Special Study

Independent research of topics not covered in listed courses. *Permission of the chair is required.*

199 Special Study – Honors

Independent study or research for majors with at least a B average in mathematics. *Permission of the chair is required.*

COMPUTER SCIENCE

The courses in computer science emphasize fundamental principles and computer structure. They introduce students to the design and applications of computer systems, and prepare students to use computers as tools in solving complex problems. For 3+2 Computer Science, see 3+2 Engineering Program.

PREREQUISITE GRADES

Any course listed in this department with a prerequisite assumes a grade of C– or better in the prerequisite course, including the high school courses algebra I, geometry and algebra II, which are prerequisites of all mathematics and computer science courses.

C O U R S E S

LOWER DIVISION

MA/CS 002 Digital Literacy, Introduction to Web Design

This course introduces students in an accessible way to the basics of digital literacy through web design as a stepping-stone to computer programming concepts and applications. Students are introduced to web development including (1) design principles, (2) information architecture, and (3) interactivity design. Primary development tools include HTML5 and CSS3. Class projects develop knowledge, research and problem solving skills needed for the design, development, and testing of interactive media projects. This course does not fulfill the mathematics core curriculum requirement, nor does it count towards a mathematics major or the 3+2 Engineering Program.

21 Programming

An introduction to problem-solving concepts and program design. Topics covered include top-down design with a structured programming language, bottom-up testing, control statements and structured data types. No prior knowledge of programming is required. The language for the course is Python or C++; students with knowledge of another programming language will find the course valuable. *Prerequisites: Math 27 or permission of instructor. Offered each spring.*

UPPER DIVISION

Consult the department chair for the schedule of offerings.

102 Advanced Programming

A continuation of **Computer Science 21**. Topics include recursion, an introduction to data structures, analysis of algorithms and object-oriented programming. Programming style and large program development are emphasized. *Prerequisites: Computer Science 21 or an equivalent C++ based course.*

110 Computer Systems

Computer structure and machine languages, assembly language macros, file I/O, program linkage and segmentation. *Prerequisites: Computer Science 102 or equivalent.*

174 Analysis of Algorithms

Basic notions of the design and efficiency of computer algorithms, nonnumerical algorithms for sorting and searching and numerical algorithms. Underlying data structures are examined. *Prerequisites: Computer Science 102 and Math 28 or equivalent.*

190 Topics in Computer Science

This course presents connections among different disciplines which apply the principles of computer science. The theme varies. Students are required to complete a significant project involving their primary discipline. *Prerequisites: varies with topic.*

MA/CS 192 Digital Literacy: Web Programming

This course is a continuation of **MA/CS-002** that introduces students to the basics of digital literacy through web design as a stepping-stone to computer programming concepts and applications. **MA/CS-192** refines & builds upon this knowledge studying JavaScript, jQuery, Web API's and simple mobile applications while implementing a team-oriented project development approach. Other topics include responsive web design, CSS grid systems and HTML5 Canvas. *Prerequisite: MA/CS 002. This course does not fulfill the mathematics core curriculum requirement, nor does it count towards a mathematics major or the 3+2 Engineering Program.*

197 Special Study

Independent study in topics not covered in listed courses. *Permission of the department chair is required.*